AP Chemistry: Thermodynamics

AP Chemistry Thermodynamics WS 0809.doc

Name: _____ Date: _____ Per: _____

1. The following equation represents the essential change that takes place during the fermentation of glucose to ethanol:

$C_6H_{12}O_{6(s)} \rightarrow 2C_2H_5OH_{(l)} + 2CO_{2(g)}$

Is ΔS^o positive or negative? Explain.

2. Calculate the change of entropy, ΔS^o, at 25.0°C for the reaction in which urea is formed from NH_3 and CO_2.

$2NH_{3(g)} + CO_{2(g)} \rightarrow NH_2CONH_{2(aq)} + H_2O_{(l)}$

The standard entropy of urea is 174 J/molK. See the text appendices for additional values.

3. Using values of ΔH^o_f and S^o, calculate the standard free energy change, ΔG^o, for the following reaction at 25.0°C.

$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

4. Using standard free energies of formation, calculate ΔG^o for the combustion of 1 mol of ethanol, C_2H_5OH, at 25.0°C.

$C_2H_5OH_{(l)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(g)}$

5. Calculate ΔH^o and ΔG^o for the reaction

$KClO_{3(s)} \rightarrow 2KCl_{(s)} + 3O_{2(g)}$

Interpret the signs obtained for ΔH^o and ΔG^o. Values of ΔH^o_f (in kJ/mol) are as following: $KClO_{3(s)}$ = -397.7; $KCl_{(s)}$ = -436.7. Similarly, values of ΔG^o_f (in kJ/mol are: $KClO_{3(s)}$ = -296.3; $KCl_{(s)}$ = -408.8. Note that $O_{2(g)}$ is the reference form of the element, so $\Delta H^o_f = \Delta G^o_f = 0$ for it.

6. Write expressions for the "thermodynamic" equilibrium constants for each of the following reactions:

a. $2NH_{3(g)} + CO_{2(g)} \leftrightarrow NH_2CONH_{2(aq)} + H_2O_{(l)}$

b. $AgCl_{(s)} \leftrightarrow Ag^+_{(aq)} + Cl^-_{(aq)}$

7. Find the value of the equilibrium constant K at 25°C (298K) for the reaction

$$2NH_{3(g)} + CO_{2(g)} \leftrightarrow NH_2CONH_{2(aq)} + H_2O_{(l)}$$

The standard free energy change, ΔG^o, at 25.0°C equals -13.6kJ

8. Calculate the equilibrium constant K_{sp} at 25.0°C for the reaction:

$$AgCl_{(s)} \leftrightarrow Ag^+_{(aq)} + Cl^-_{(aq)}$$

using standard free energies of formation.

9. a. What is ΔG^o at 1,000.°C for the following reaction?

$$CaCO_{3(s)} \leftrightarrow CaO_{(s)} + CO_{2(g)}$$

Is this reaction spontaneous at 1,000.°C and 1.00atm?

b. What is the value of K_p at 1,000.°C for this reaction? What is the partial pressure of CO_2?

10. To what temperature must magnesium carbonate be heated to decompose it to MgO and CO_2 at 1.00atm? Values of ΔH^o_f (in kJ/mol) are: $MgO_{(s)}$ = -601.2; $MgCO_{3(s)}$ = -1111.7. Values of S^o (in J/K) are: $MgO_{(s)}$ = 26.9; $MgCO_{3(s)}$ = 65.9